

# QuikSCAT for wind energy resource assessment

Oral presentation

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*Publication date:*
2011

*Document Version*
Publisher's PDF, also known as Version of record

# QuikSCAT for wind energy resource assessment

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# Purpose

- Wind farm planing and siting moves towards offshore locations
- Difficult to obtain in situ observations
- Use QuikSCAT observations for an initial estimation of the wind resource over large areas
- Demonstrate the high quality of QuikSCAT when compared with in situ measurements
- Evaluate wind characteristics relevant for wind resource assessment

# Wind from QuikSCAT

- Sun-synchronous, polar orbiting platform, altitude 803 km
- Swath: 1800 km $\rightarrow$ 90% of Earth's surface/day
- Wind Speed 3-20 m $s^{-1}$, accuracy of 2 m $s^{-1}$
- Wind Direction, accuracy of 20°
- **Active Microwave Radar**: emits radiation, measures backscattered signal
- Geophysical Model Function (GMF) to derive wind speed and direction
- Equivalent Neutral Wind (ENW) at 10 m above the sea surface

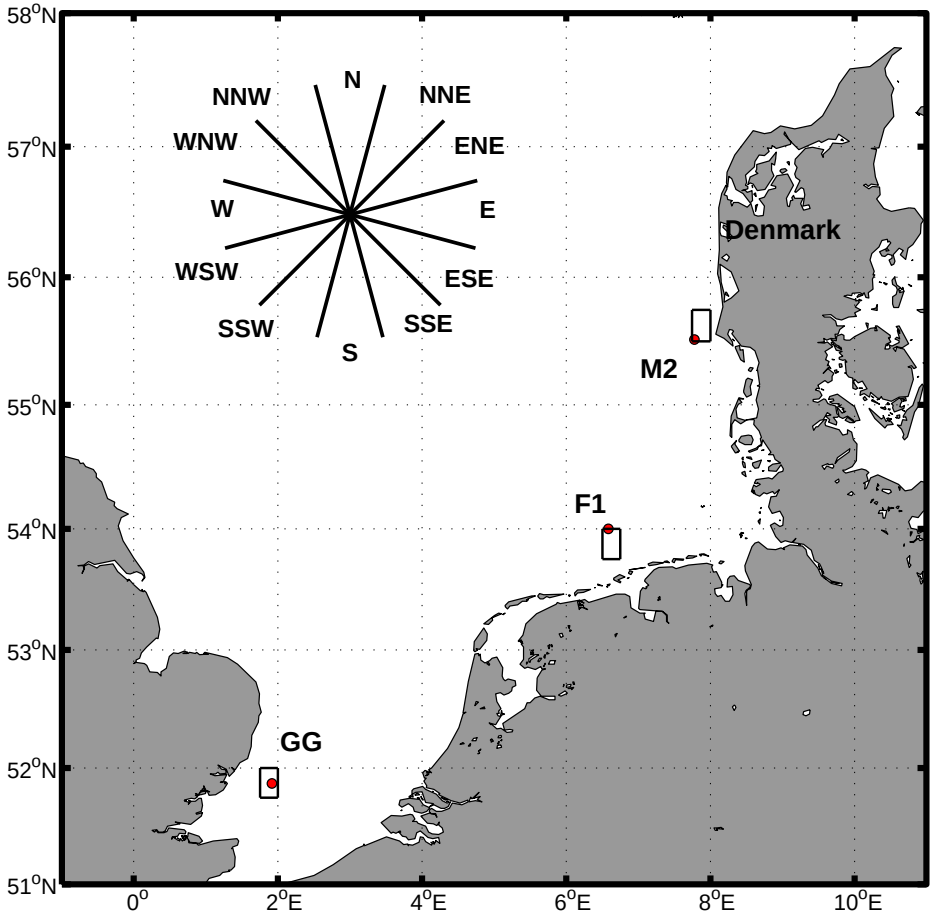
# Data & Methods

Data:

1. QuikSCAT, gridded winds from RSS
2. 10 years (01/11/99 - 31/10/09), twice daily
3. 4 years of met. mast measurements

Methods:

1. 10 min measurement closest to QuikSCAT time
2. Convert in situ observations to ENW
3. Derive stability information ($\Psi_M$), from the air-sea temperature difference
4. Estimate $u_*$ from measurements at a height: $u = \frac{u_*}{\kappa}\left[\ln\left(\frac{z}{z_0}\right) - \Psi_M\right]$
5. Estimate $u_{10\ m}$ from $u_*$, assuming that $\Psi_M$ is zero (neutral).

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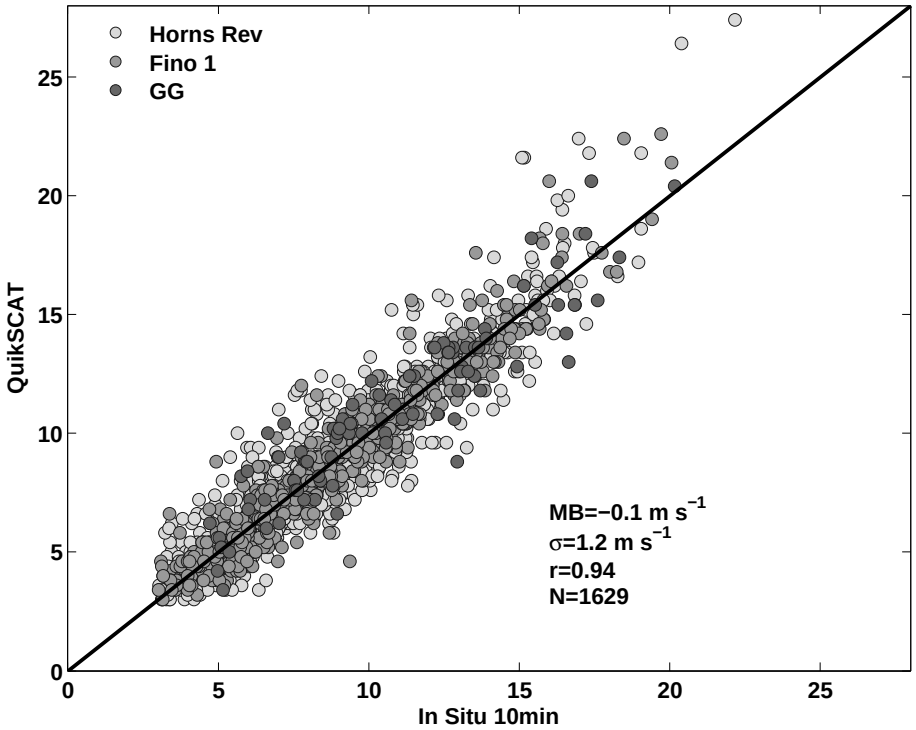
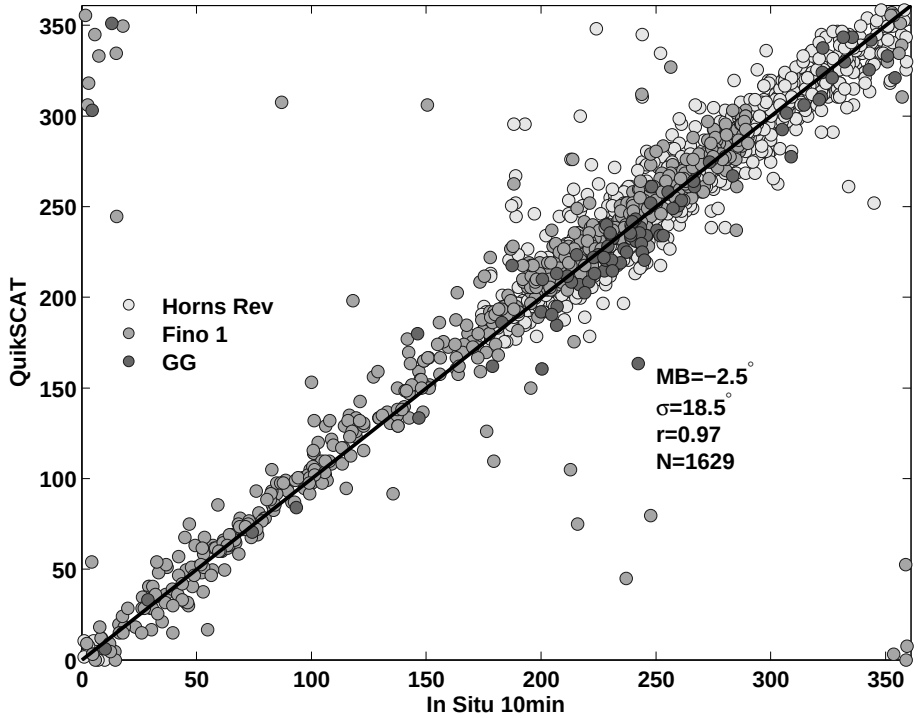
# QuikSCAT and In situ observations




Wind speed




Wind direction

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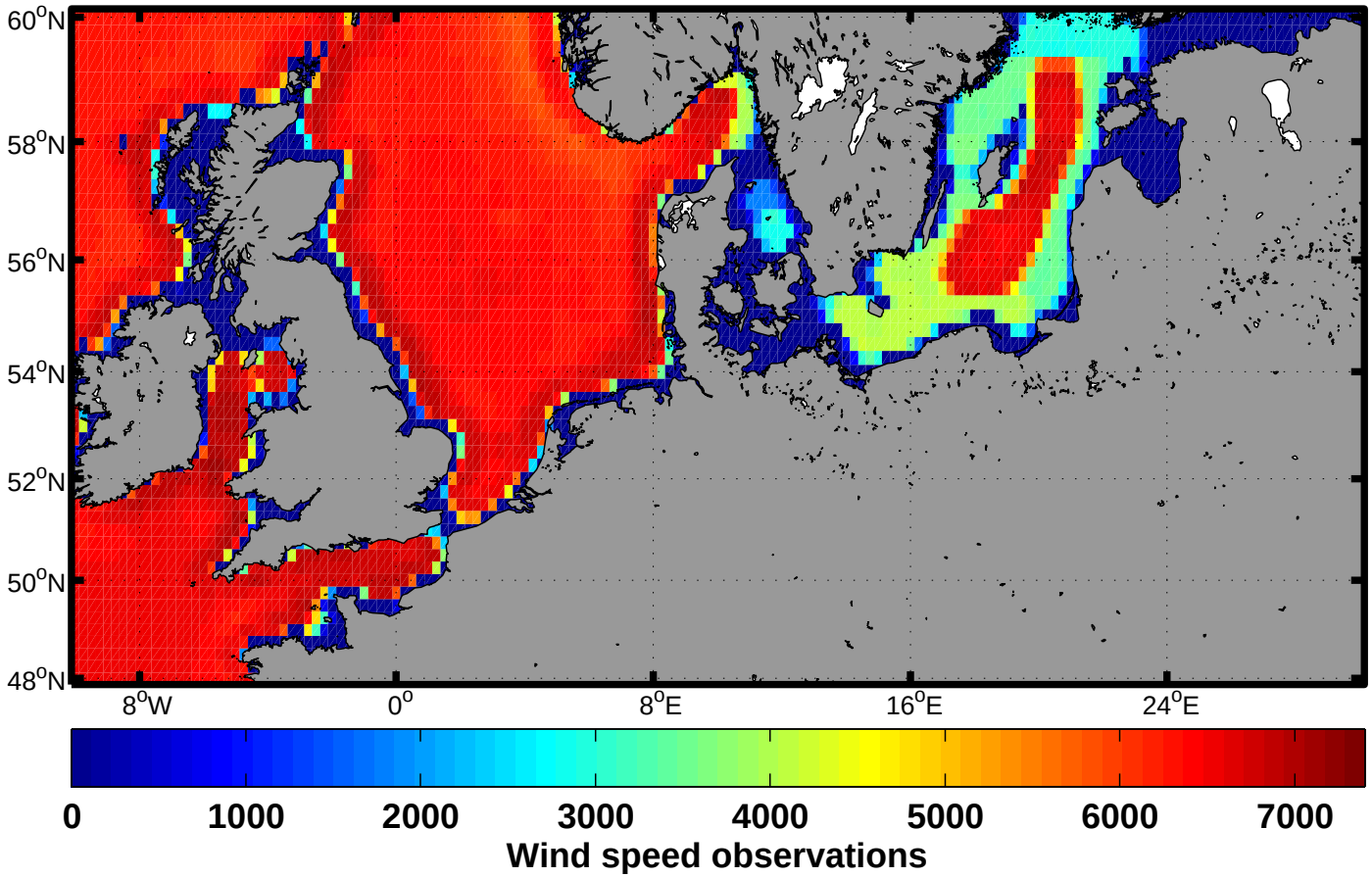
# QuikSCAT and In situ observations

Table: Mean wind speed and wind power density estimates from QuikSCAT and in situ observations a) converted to ENW or b) preserving the stability information (SDIS: stability dependent in situ)

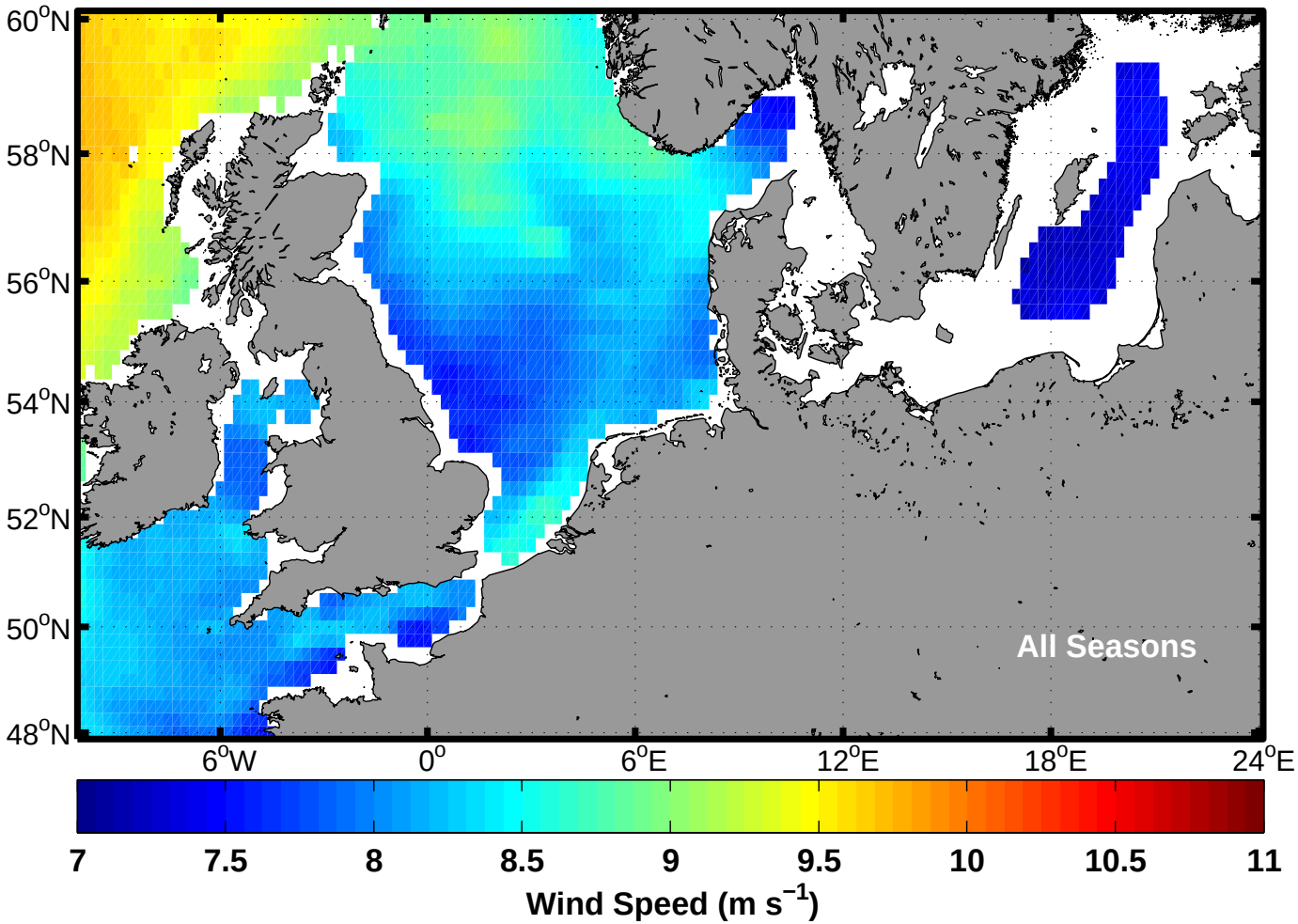
| | Product | Sample N. | u ($m\ s^{-1}$) | u Dev. (%) | E ($W\ m^{-2}$) | E dev. (%) |
|---|---|---|---|---|---|---|
| M2 | | | | | | |
| | QSCAT | 1601 | 7.97 | 2.7 | 515 | 14.2 |
| | 10 m ENW | 1601 | 7.96 | 2.5 | 479 | 6.2 |
| | 10 m SDIS | 1601 | 7.88 | 1.54 | 470 | 4.2 |
| | All 10 m SDIS | 137717 | **7.76** | – | **451** | – |
| Fino 1 | | | | | | |
| | QSCAT | 642 | 8.42 | 0.8 | 593 | 2.6 |
| | 10 m ENW | 642 | 8.26 | -1.1 | 563 | -2.6 |
| | 10 m SDIS | 642 | 8.45 | 1.2 | 575 | -0.5 |
| | All 10 m SDIS | 50349 | **8.35** | – | **578** | – |

# Wind resources from QuikSCAT




Rain free observations

# Wind resources from QuikSCAT




Mean wind speed

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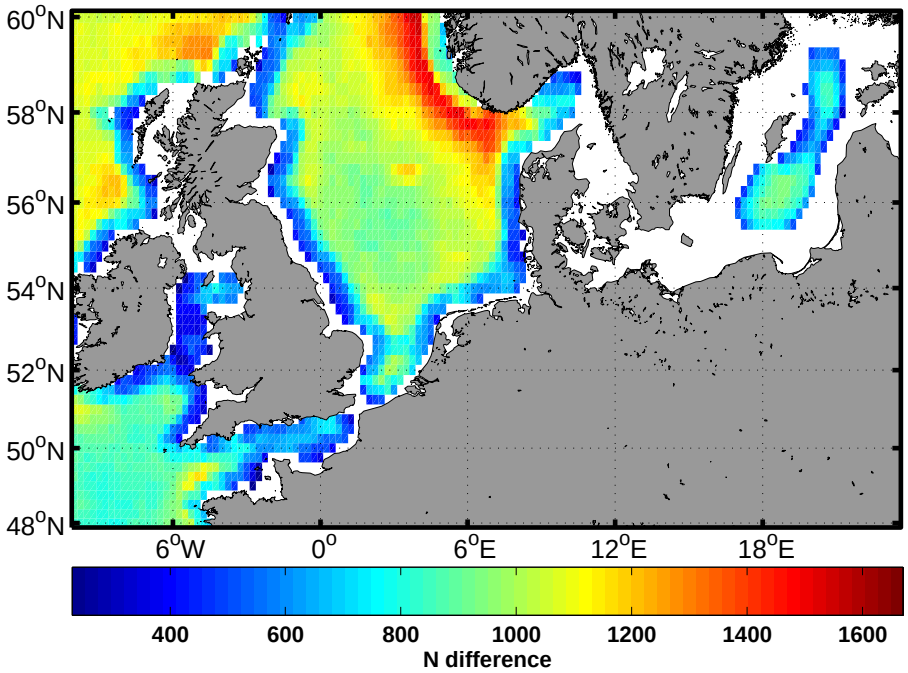
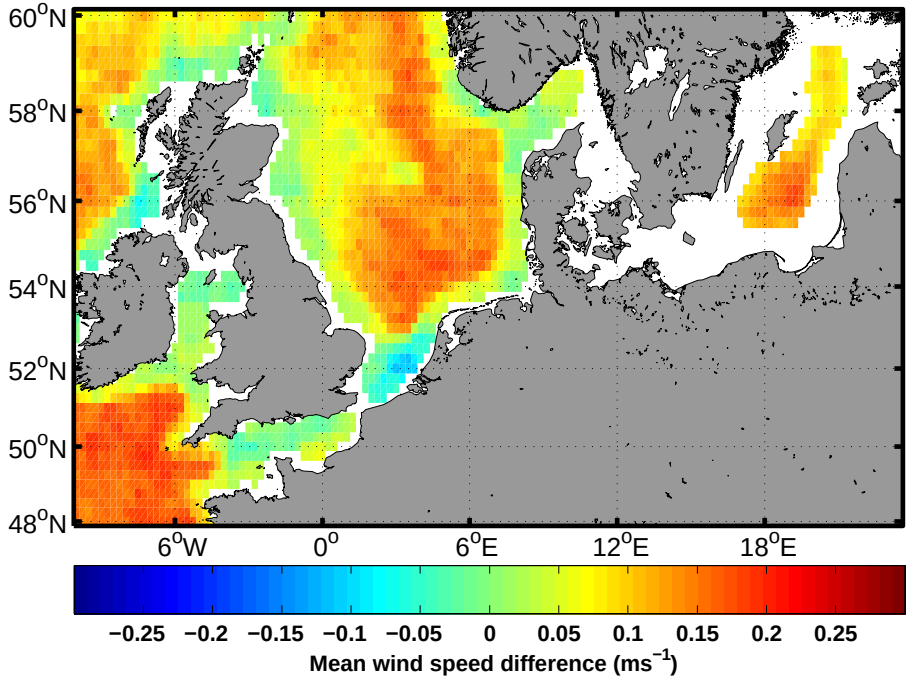
# Wind resources from QuikSCAT




N of rain vs. rain-free retrievals




Mean wind speed difference

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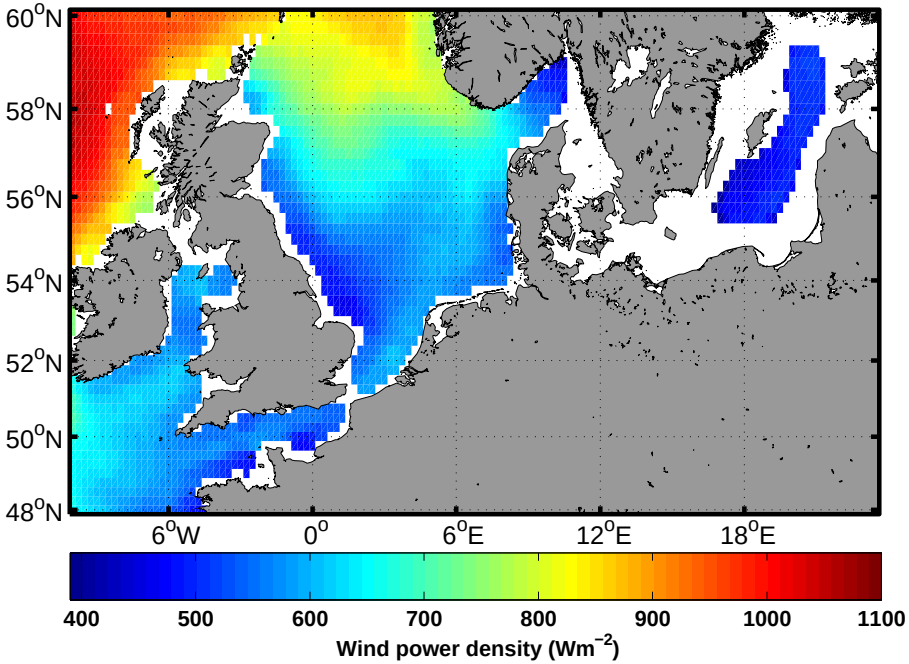
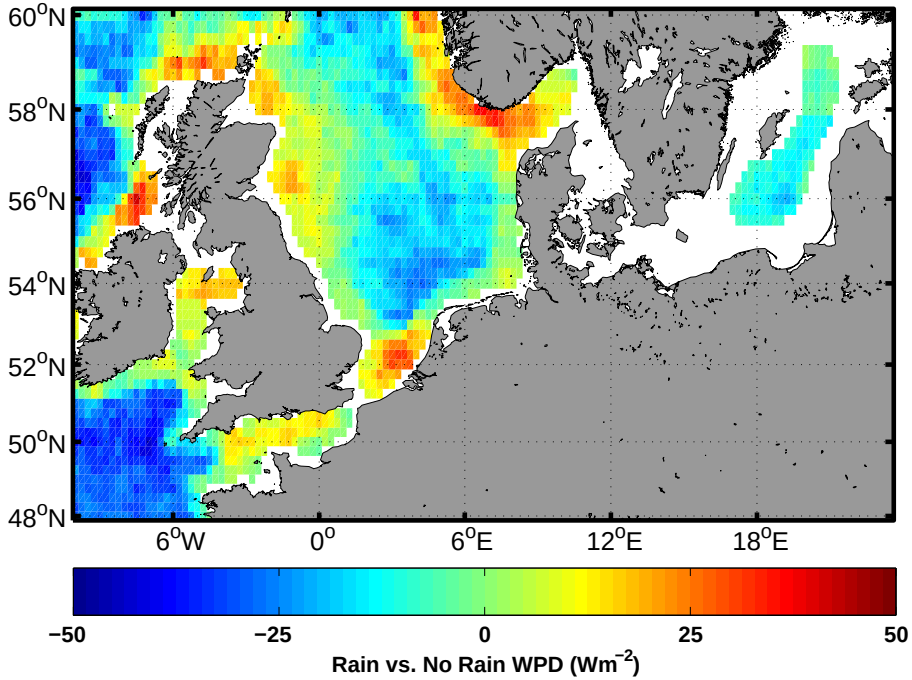
# Wind resources from QuikSCAT

- Wind power density (WPD): $E = \frac{1}{2}\rho\overline{u^3}$




WPD: rain-free observations




Difference in estimated WPD: rain vs. rain-free observations

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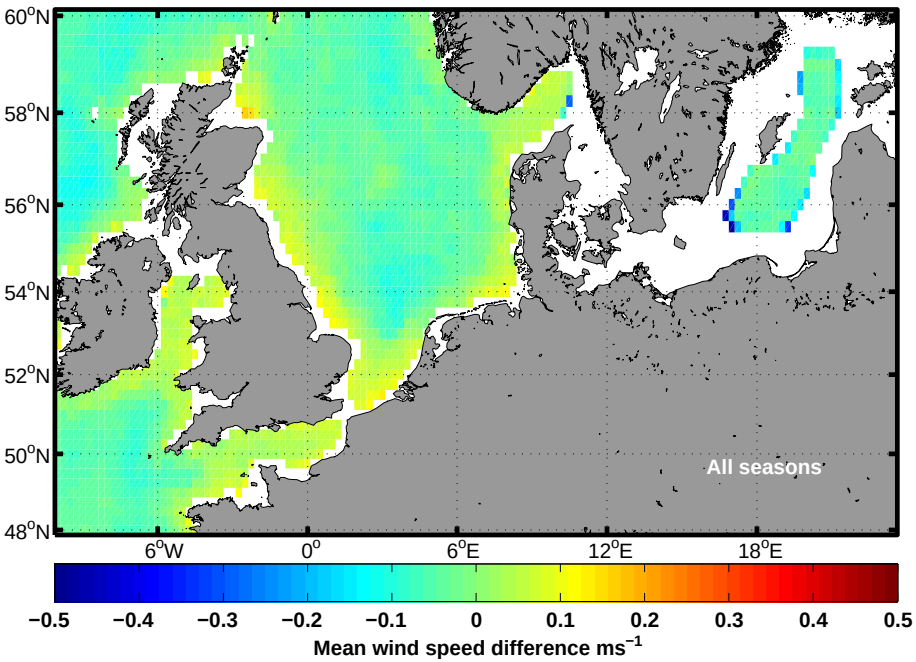
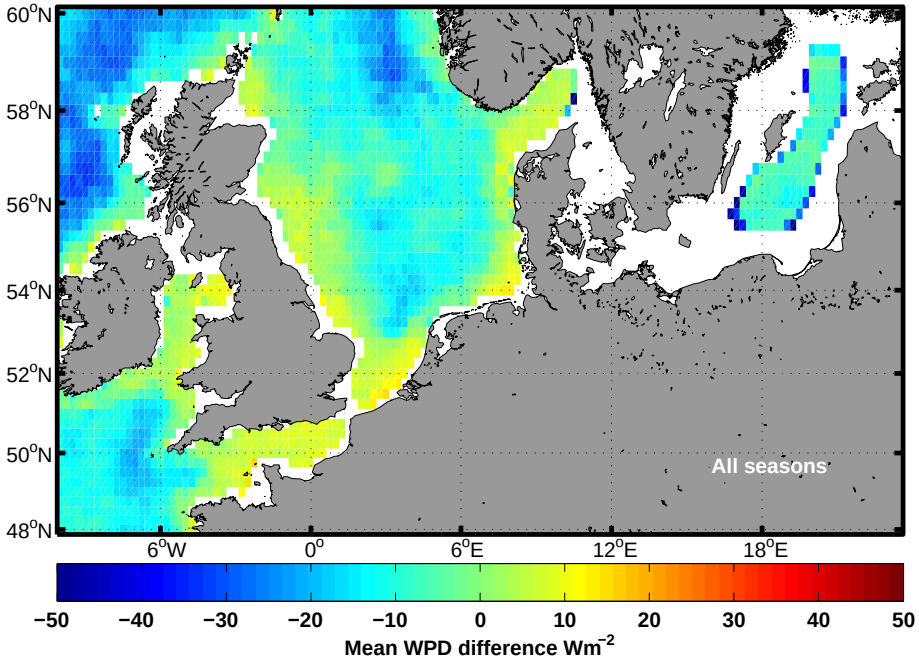
# 2 passes per day: Is that representative enough?

- Hahmann et al: A reanalysis system for the generation of mesoscale climatographies, J Appl. Meteor. Climatol. 2010




U: 24hourly 10-yr vs. 2 fields/day




WPD: 24hourly 10-yr vs. 2 fields/day

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# Conclusions

1. Very good agreement between in situ and QSCAT observations
   - QSCAT-In Situ wind speed: MB=-0.1 m $s^{-1}$,$\sigma$=1.2 m $s^{-1}$, $R^2$=0.94
   - QSCAT-In Situ wind direction: MB=-2.5°,$\sigma$=18.5°, $R^2$=0.97
2. Worst case scenario: 14% higher WPD estimates from QuikSCAT when compared to in situ
3. Highest mean wind speeds in the North Atlantic and northern North Sea
4. Intense lee effects from the British Isles
5. Maximum wind speed difference of 0.25 m $s^{-1}$ for rain contaminated vs. rain free retrievals
6. Maximum data loss, 1650 observations
7. Estimated wind power density in the North Sea: 600-700 W $m^{-2}$
8. In the North Atlantic, WPD up to 1100 W $m^{-2}$
9. Maximum bias in WPD estimates, 50 W $m^{-2}$
10. No significant impact of the low temporal frequency to the long-term representativity
11. QuikSCAT not operational but new missions: ASCAT, OceanSat-2

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# Thank you for your attention